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INVENTOR-INFORMATION:

NAME	COUNTRY
HIKIJI, TAKETO	N/A
YAMAMOTO, SHIGERU	N/A
HIJI, NAOKI	N/A
SUZUKI, SADAICHI	N/A
NINOMIYA, MASANOBU	N/A

ASSIGNEE-INFORMATION:

NAME	COUNTRY
FUJI XEROX CO LTD	N/A

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ABSTRACT:

PROBLEM TO BE SOLVED: To produce a polymer dispersion type liquid crystal element having high reflectance.

SOLUTION: A polymerizable compound containing a compound having a photodimerizable structure and plural polymerizable groups, a low molecular weight liquid crystal and a polymerization initiator for the polymerizable groups are mixed to prepare a polymerizable composition, and this composition is injected into a cell 30. When the resultant cell 30 is irradiated with coherent laser light 11 in regions in which the amplitude of the light 11 is large, the polymerizable compound is cured to form polymer layers 9 having a low refractive index. In regions in which the amplitude of the light 11 is small, polymerization and phase separation are caused to form polymer dispersion type liquid crystal layers 10 having a high refractive index. When the resultant cell 30 is irradiated with polarized light 12, the low molecular weight liquid crystal in the cell 30 is aligned in a specified direction. The periodic variation

of the refractive index of the layers 10 increases and the objective polymer dispersion type liquid crystal element having high reflectance is obtained.

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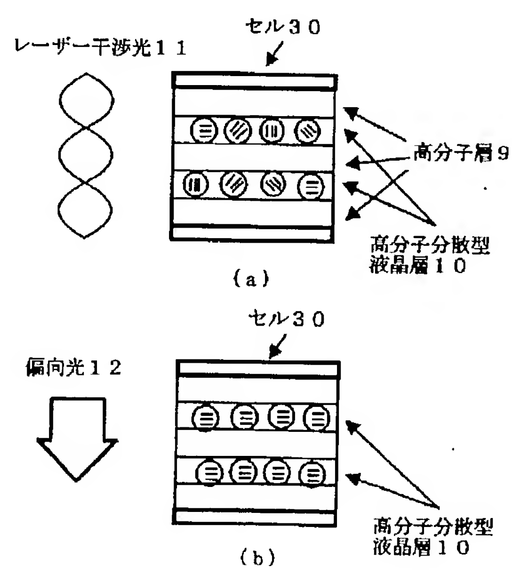
(71)出願人　000005496
富士ゼロックス株式会社
東京都港区赤坂二丁目17番22号
(72)発明者　曳地　丈人
神奈川県足柄上郡中井町境430　グリーンテクなかい　富士ゼロックス株式会社内
(72)発明者　山本　滋
神奈川県足柄上郡中井町境430　グリーンテクなかい　富士ゼロックス株式会社内
(74)代理人　100093470
弁理士　小田　富士雄　（外１名）

最終頁に続く

(54)【発明の名称】　高分子分散型液晶素子及びその製造方法

(57)【要約】
【課題】　高い反射率を有する高分子分散型液晶素子及びその製造方法を提供する。
【解決手段】　光２量化性構造を有し且つ複数の重合性基を有する化合物を含有する重合性化合物と低分子液晶及び重合性基の重合開始剤を混合して重合性組成物を調液し、セル３０に注入する。このセル３０に、レーザー干渉光１１を照射すると、レーザー干渉光１１の振幅の大きな領域では重合性化合物の硬化が起こり、屈折率の低い高分子層９が形成される。またレーザー干渉光１１の振幅の小さな領域では重合相分離が起こり、屈折率の高い高分子分散型液晶層１０が形成される。このセル３０に偏向光１２を照射すると、高分子分散液晶素子中の低分子液晶が特定の方向へ配向する。その結果、周期的な屈折率の変化量が増大し、高い反射率を有する高分子分散液晶素子が得られる。



【特許請求の範囲】

【請求項１】　少なくとも光２量化性構造を有し且つ複数の重合性基を有する重合性化合物と低分子液晶を含有する重合性組成物を重合相分離させることにより製造されることを特徴とする高分子分散型液晶素子。

【請求項２】　内部で屈折率が周期的に変化する層構造を有することを特徴とする請求項１記載の高分子分散型液晶素子。

【請求項３】　前記重合性化合物が光２量化性構造を複数個有することを特徴とする請求項１又は２記載の高分子分散型液晶素子。

【請求項４】　前記光２量化性構造が複数個のベンゼン環を有することを特徴とする請求項１乃至３のいずれかに記載の高分子分散型液晶素子。

【請求項５】　前記光２量化性構造がシアノ基を有することを特徴とする請求項１乃至３のいずれかに記載の高分子分散型液晶素子。

【請求項６】　光２量化した高分子化合物と低分子液晶の複合構造で構成され、内部で屈折率が周期的に変化する層構造を有することを特徴とする高分子分散型液晶素子。

【請求項７】　少なくとも光２量化性構造を有し且つ複数の重合性基を有する重合性化合物と低分子液晶を含有する重合性組成物を重合相分離させ、次いで、偏向光を照射して低分子液晶を配向させることを特徴とする高分子分散型液晶素子の製造方法。

【請求項８】　前記重合性組成物に定在波を照射することにより重合相分離させ、内部で屈折率が周期的に変化する層構造を形成することを特徴とする請求項７記載の高分子分散型液晶素子の製造方法。

【請求項９】　前記定在波がレーザー干渉光により得られたものであることを特徴とする請求項８記載の高分子分散型液晶素子の製造方法。

【請求項１０】　少なくとも光２量化性構造を有し且つ複数の重合性基を有する重合性化合物と低分子液晶を含有する重合性組成物に、偏向光を照射して、重合相分離させると同時に低分子液晶を配向させることを特徴とする高分子分散型液晶素子の製造方法。

【請求項１１】　少なくとも光２量化性構造を有し且つ複数の重合性基を有する重合性化合物と低分子液晶を含有する重合性組成物を重合相分離させて作製した高分子分散型液晶素子に偏向光を照射することにより低分子液晶を配向させることを特徴とする高分子分散型液晶素子中の低分子液晶の配向方法。

【請求項１２】　前記偏向光が偏向紫外線であることを特徴とする請求項１１記載の高分子分散型液晶素子中の低分子液晶の配向方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、電場や磁場等の印加によって反射率や透過率を制御することが可能な高分子分散型液晶素子およびその製造方法に関するものである。本発明により製造された高分子分散型液晶素子は、ディスプレイ、調光素子、光変調素子等の光学素子として応用可能である。

【０００２】

【従来の技術】表示用素子および調光素子として、図１に示すような３次元構造のポリマーの空隙中に液晶を分散させた高分子分散型液晶（ＰＤＬＣ）が研究されている。ＰＤＬＣは、図のように、二つの基板２の間に液晶領域３と高分子領域４とを備える。電圧が印加されない状態では、図１（ａ）に示すように、空隙中の液晶の屈折率とポリマーの屈折率の差により界面で入射光１が屈折し、膜全体で多数のドロプレットを通過することにより、入射光１は散乱光６となる。これに電圧を印加すると、図１（ｂ）に示すように、液晶分子５は基板２と垂直に配向し、液晶の長軸方向の屈折率とポリマーの屈折率とが一致してＰＤＬＣ膜は透明となり、入射光１は透過光７として得られる。このＰＤＬＣの技術では偏光板が不要であり、プロジェクタライトバルブへの応用が検討され、明るい表示が期待されている。

【０００３】これらの３次元ポリマーの構造は、液晶が分布する空隙が互いに独立に存在するものや、連続的に分布するものがある。このような液晶高分子複合膜の製造方法としては、大きく分けて３つの方法が提案されている。第１は、多孔質ポリマーに液晶を含浸させる方法であり、第２は、溶媒中でポリマーと液晶を混合して乳化させた後、溶媒を蒸発させることによりポリマーを硬化させる方法であり、第３は、モノマーやオリゴマー、またはそれらの混合物と液晶を混合した重合性組成物を、熱又は紫外線の照射などの手段を用いて重合させる過程を通して、重合したポリマーと液晶を相分離させる方法である。

【０００４】また、この高分子分散型液晶の応用として、ＳＰＩＥ．１０８０，８３，（１９８９）には、内部で周期的に屈折率が変化する高分子分散型液晶素子が開示されている。具体的には図２のように、高分子層９と高分子分散型液晶層１０とを交互に積層した構造を作製することにより、屈折率が周期的に変化する層構造を実現したものである。この場合、電圧が印加されない状態では、図２（ａ）に示すように、高分子分散型液晶層１０と高分子層９との周期的な屈折率差に起因した干渉フィルタの原理により、入射光１が反射されて反射光８を生じる。これに電圧が印加されると、図２（ｂ）に示すように、高分子分散型液晶層１０と高分子層９との屈折率が一致して膜は透明となり、入射光１は膜を通過して透過光７となる。

【０００５】

【発明が解決しようとする課題】図１に示すような従来のＰＤＬＣでは、散乱性が低いという問題がある。その

原因は高分子領域と液晶領域の屈折率差が小さいことによる。このため、従来のＰＤＬＣは直視型のディスプレーに適用することが困難であり、その応用が投射型のシャッターに限定されていた。また、図２に示すように、従来の、内部で周期的に屈折率が変化する高分子分散型液晶素子では、高分子分散型液晶層中のドロプレット内の低分子液晶の配向は、高分子分散型液晶層全体ではランダムとなる。従って、高分子分散型液晶層の屈折率は、ドロプレットの一次近似された屈折率（n_e＋２n_o）／３、高分子分散型液晶層中の高分子の屈折率の値（n_pは略n_o）、高分子分散型液晶層中の低分子液晶の高分子に対する体積分率の値（ｖ）から、｛n_o（３－ｖ）＋n_e｝／３という値に低下する。ここで、n_pはポリマーの屈折率、n_oは光の電場の振動方向が液晶分子の長軸と直交する場合の屈折率、n_eは光の電場の振動方向が液晶分子の長軸と平行な場合の屈折率を示す。このため、高分子分散型液晶層と高分子層との屈折率差が小さくなり、高い反射率が得られないという問題があった。よって、内部で周期的に屈折率が変化する高分子分散型液晶素子の反射率を高めるために、素子中の低分子液晶の配向を揃える技術が求められているが、そのような技術は知られていない。

【０００６】類似の技術として、ＰＤＬＣ中の初期状態におけるドロプレット内の低分子液晶の配向方向を制御する技術はいくつか提案されている。例えば、①米国特許第５１８８７６０号明細書には、液晶性高分子を用いたＰＤＬＣと配向膜との組合せによる配向制御技術が開示されている。この技術は、液晶性モノマーをＰＤＬＣの前駆体である重合性組成物に用い、それを配向膜付きセルに注入する。この状態でＵＶや熱を加えることにより、液晶性モノマーの重合体である液晶性高分子と低分子液晶が配向膜の方向に配向した状態で重合相分離を行い、液晶性モノマー硬化後には、低分子液晶の配向が固定される。

【０００７】また、②特開平５－２８１５２７号公報には、ＰＤＬＣと水平外部磁場や電場との組合せによる配向制御技術が開示されている。この技術では、重合性組成物を配向膜のないセルの内部に注入し、このセルに対して水平方向に外部磁場や電場を印加した状態で、ＵＶや熱を加えることにより、低分子液晶が外部磁場や電場の方向に配向した状態で重合相分離を行い、重合性組成物硬化後に、低分子液晶の配向が固定される。

【０００８】また、③Ｊａｐａｎ　Ｄｉｓｐｌａｙ’９２，６９９には、ＰＤＬＣと配向膜との組合せによる配向制御技術が開示されている。この技術では、ＰＤＬＣの前駆体である重合性組成物を、液晶濃度が非常に高い液晶相となるように調製し、それを配向膜付きセルに注入する。この状態では、液晶相状態の重合性組成物は配向膜の方向に配向しているが、この状態にＵＶや熱を加えて配向膜付きセルの内部で重合相分離させることにより、初期配向の状態を保ったまま低分子液晶の配向が固定される。

【０００９】さらに、④Ｍｏｌ．Ｍａｔ．，２，２９５（１９９３）には、光２量化性構造を有する高分子化合物を用いた配向制御技術が開示されている。この技術は、材料として光２量化性構造を有する高分子化合物を用いた含浸法で作製するものである。まず、乳化法で光２量化性構造を有する高分子化合物と該高分子化合物の貧溶媒からなる複合膜を作製し、この複合膜から貧溶媒を抽出し、乾燥させて、光２量化性構造を有する高分子化合物からなる多孔質ポリマーを作製する。さらに、この多孔質ポリマーに偏向光を照射して光２量化反応を起こさせる。この光２量化反応による高分子化合物の構造変化に伴い、低分子液晶に対する配向規制力を発現させる。その後、低分子液晶を多孔質ポリマーに含浸させることにより、液晶粒中の低分子液晶が配向した状態のＰＤＬＣを作製する。

【００１０】しかしながら、このうち、①及び③の配向固定方法では、配向膜を用いなければならないために、図２のような複合構造を作製することができなかった。また、②の配向固定方法では、セルと平行に外部磁場や電場を印加する必要があるが、セルサイズが大きい場合は、セルの面内一面にわたって有効な外部磁場や電場を印加することが非常に困難であった。例えば、特開平５－２８１５２７号公報には、外部電場を印加する場合は外部電場の大きさが１ｋＶ／ｃｍ以上であることが必要であると記載されている。ここで、セルサイズが対角１２インチであると仮定すると、印加電圧は約３５０ｋＶ以上必要となる計算になるが、このように大きな印加電圧は容易には実現できない。さらに、④は、材料として光２量化性構造を有する高分子化合物を用いるため、含浸法でしか作製できない。また、含浸法では図２のような複合構造を作製することはできない。このように、従来の液晶配向方法はいずれも問題点を有しており、十分な反射率を有する高分子分散型液晶素子は得られていない。

【００１１】したがって本発明の目的は、高い反射率を有する高分子分散型液晶素子及びその製造方法を提供することにある。

【００１２】

【課題を解決するための手段】本発明者等は鋭意研究を重ねた結果、重合性化合物として光２量化性構造を有するものを混合し、高分子分散型液晶素子の形成後に偏向光を照射することによって液晶分子が配向することを見出した。その結果、ＨＰＤＬＣの反射率は改善された。そして画質向上のために更に努力を重ねた結果、光２量化性構造を有する重合性化合物として複数の重合性基を有する化合物を含有するものを使用した場合には、重合性基が単数のものに比べて配向性が良くなり、反射率が一層改善されることを見出し本発明に至った。重合性基

が単数である単官能の重合性化合物を適用した場合には、それがHPDLCの微細な周期構造の形成を阻害する働きを有する為にその添加量が微量に制限され、したがって添加量が十分でないことにより、光２量化による液晶の配向性が不十分となり、僅かな特性向上しか実現できない。

【００１３】本発明に係る高分子分散型液晶素子は、少なくとも光２量化性構造を有し且つ複数の重合性基を有する重合性化合物と低分子液晶を含有する重合性組成物を重合相分離させることにより製造されるものであり、光２量化した高分子化合物と低分子液晶の複合構造で構成され、内部で屈折率が周期的に変化する層構造を有する。ここで、重合性化合物としては、光２量化性構造を複数個有するものを用いることができる。また、光２量化性構造としては、複数個のベンゼン環を有するもの、あるいはシアノ基を有するものを用いることができる。

【００１４】本発明に係る高分子分散型液晶素子の製造方法は、少なくとも光２量化性構造を有し且つ複数の重合性基を有する重合性化合物と低分子液晶を含有する重合性組成物を重合相分離させ、次いで、偏向光を照射して低分子液晶を配向させて素子を製造するものである。ここで、重合性組成物に定在波を照射することにより重合相分離させ、内部で屈折率が周期的に変化する層構造を形成することができる。この定在波は、例えばレーザー干渉光により得られる。また、光２量化性構造を有する高分子化合物と重合性化合物の重合開始剤とが同時に感度を持つ波長の偏向光を照射することにより、重合相分離させると同時に低分子液晶を配向させることもできる。偏向光としては、例えば偏向紫外線が用いられる。このように構成することにより、高い反射率を有する高分子分散型液晶素子及びその製造方法を得ることができる。

【００１５】

【発明の実施の形態】最初に、本発明に係る高分子分散型液晶素子の製造方法の一例について図３を用いて説明する。本例では、レーザー干渉光を用いて高分子分散型液晶素子を作製する。まず、図３（ａ）に示すように、少なくとも光２量化性構造を有し且つ複数の重合性基を有する化合物を含有する重合性化合物と低分子液晶、および重合性基の重合開始剤を混合して重合性組成物を調液し、セル３０に注入する。このセル３０に、レーザー干渉光１１を照射すると、レーザー干渉光１１の振幅の大きな領域では重合性化合物の硬化が起こり、屈折率の低い高分子層９が形成される。またレーザー干渉光１１の振幅の小さな領域では重合相分離が起こり、屈折率の高い高分子分散型液晶層１０が形成される。このように、レーザー干渉光の振幅の大きな領域と小さな領域が空間的に交互に繰り返すため、周期的に屈折率が変化する高分子分散型液晶素子を作製することができる。

【００１６】次に、高分子分散型液晶素子中の低分子液晶の配向方法について述べる。低分子液晶の配向は、図３（ｂ）に示すように、上述のようにして作製された高分子分散型液晶素子に一様に偏向した光（偏向光）１２を照射することによって行われる。偏向光１２の波長は、光２量化性構造を有する高分子化合物の種類によって異なるが、例えばシンナメート系化合物の場合は２５０ｎｍ～３５０ｎｍの光を用いることができる。偏向光１２の照射時間は、光の強度や、光２量化性構造の感度、照射雰囲気によっても異なるが、光の強度が数ｍＪ／ｃｍ^2～数十ｍＪ／ｃｍ^{2}において１分～１２０分程度の照射が好ましい。また、光２量化性構造を有する高分子化合物と重合性化合物の重合開始剤とが同時に感度を持つ波長の偏向光を用いる場合は、重合相分離と低分子液晶の配向制御を同時に行うことができる。

【００１７】上述のように高分子分散型液晶素子に偏向光１２が照射されると、光２量化性構造を有する高分子化合物光吸収係数の異方性から、偏向光１２の振動方向と平行な方向に強い吸収を有する光２量化性構造が効率よく反応し、高分子分散液晶素子中の高分子が光２量化する。この光２量化は分子の構造変化を伴う。特定の方向を向いた分子の構造変化に伴い、図３（ｂ）に示すように、内部で屈折率が周期的に変化する層構造を有する高分子分散液晶素子中の低分子液晶は特定の方向へ配向するようになる。その結果、周期的な屈折率の変化量が増大し、従来よりも光反射率の高い、内部で屈折率が周期的に変化する層構造を有する高分子分散液晶素子の作製が可能となる。

【００１８】本発明のように、光２量化性構造を有し且つ複数の重合性基を有する化合物を用いることによって、重合相分離時に形成される微細な周期構造の形成を阻害する働きが大幅に低減され、光２量化性構造を有する重合性化合物の添加によるＨＰＤＬＣの反射率の劣化が抑制される。従って、光２量化性構造の適用による配向性向上の効果がＨＰＤＬＣの反射率に対して更に顕著になると同時に、多量の光２量化性構造の添加が可能となり、より一層の反射率の向上が可能となる。また、光２量化構造を有し且つ複数の重合性基を有する化合物を用いた一般的な高分子分散型液晶素子においても、従来の光２量化性構造を有する材料を用いた場合と比較して相分離性が向上する。従って、相分離後の偏向光の照射によって高分子分散型液晶素子中の液晶分子の配向方向を制御することにより、高い光散乱性が得られると同時に重合反応に要する照射光エネルギーの低減、照射時間の短縮といった実用的な効果が得られる。さらに、光２量化構造が複数個存在する、光２量化構造にフェニル基が複数個存在する構造、あるいは光２量化構造にシアノ基が付加されている構造とすることにより、低分子液晶の配向性が更に向上し、ＨＰＤＬＣの反射率が一層改善される。

【００１９】本発明に係る高分子分散型液晶素子を体積

ホログラム調光素子として用いた場合の一例を図４に示す。素子に電圧が印加されない状態では、図４（ａ）に示すように、高分子分散型液晶層１０と高分子層９との周期的な屈折率差に起因した干渉フィルタの原理により、入射光１が反射されて反射光８を生じる。ここで高分子分散液晶素子中の低分子液晶は、図のように特定の方向へ配向しているので、周期的な屈折率の変化量が大きく、従来よりも反射率の高い反射光８を得ることができる。素子に電圧が印加された状態では、図４（ｂ）に示すように、高分子分散型液晶層１０と高分子層９との屈折率が一致して膜は透明となり、入射光１は膜を通過して透過光７となる。

【００２０】次に本発明に用いられる重合性組成物について説明する。重合性組成物は、少なくとも光２量化性構造を有し且つ複数の重合性基を有する化合物を含有する重合性化合物と低分子液晶と重合開始剤からなる。本発明における光２量化性構造とは、図５（ａ）に示すシンナモイル基もしくはそれに類似した構造を指しており、具体的には図５（ｂ）に示すナフタレン構造、図５（ｃ）に示すビフェニル構造、図５（ｄ）に示すシアノビフェニル構造等が挙げられる。光２量化性構造はこれらに限定されるものではなく、これらに類似した構造を有するものであれば同様の効果が得られる。

【００２１】また、光２量化性構造を有し且つ複数の重合性基を有する化合物とは、光２量化性構造をもった化合物に、重合性基であるアクリロイル基やメタクロイル基を複数付与した化合物およびその誘導体をいう。具体的な重合性化合物としては、例えば２官能の化合物としては、シンナミルジアクリレート、シンナミルジメタクリレート、シンナモイロキシエチルジアクリレート、シンナモイロキシエチルジメタクリレート、シンナミリデンエチルジアクリレート、シンナミリデンエチルジメタクリレート等があげられる。更に本発明を実現する為には２官能である必然性はなく、多官能であればよい。多官能のものでは２官能と同等若しくはそれ以上の効果が得られる。

【００２２】また、本発明に使用される重合性組成物は、少なくとも前記の光２量化性構造を有する重合性化合物を含むが、それ以外にも種々の重合性化合物を組み合せて使用することができる。例えば、アクリル酸アルキルエステル、アクリルアミド、アクリル酸ヒドロキシエステル、メタクリル酸アルキルエステル、メタクリルアミド、メタクリル酸ヒドロキシエステル、ビニルピロリドン、スチレンおよびその誘導体、アクリロニトリル、塩化ビニル、塩化ビニリデン、エチレン、ブタジエン、イソプレン、ビニルピリジン等の単官能および多官能モノマーが好ましく用いられる。また、本発明における重合性組成物には、重合性化合物を重合させる目的で重合開始剤が含まれる。重合開始剤は内部で周期的に屈折率が変化する高分子分散型液晶素子を作製する際に用いる定在波の波長に、感度をもつ材料の中から選択される。さらに、光２量化性構造を有し且つ複数の重合性基を有する化合物は、単独でも感光性を有するが、感光色素や増感剤などと併用することによって感光感度を増加させたり、感光波長を選択したりすることもできる。

【００２３】次に、本発明に用いられる低分子液晶について説明する。本発明の高分子分散型液晶を構成する低分子液晶化合物は、ネマチック液晶、コレステリック液晶、スメクチック液晶、および強誘電性液晶等、一般的に電界駆動型表示材料として使用されている種々の低分子液晶材料が使用可能である。具体的にはビフェニル系、フェニルベンゾエート系、シクロヘキシルベンゼン系、アゾキシベンゼン系、アゾベンゼン系、ターフェニル系、ビフェニルベンゾエート系、シクロヘキシルビフェニル系、フェニルピリミジン系、シクロヘキシルピリミジン系等の各種低分子液晶化合物があげられる。これらの低分子液晶化合物は、一般に使用されている低分子液晶材料と同様に、単一の組成である必要はなく、複数の成分から構成される化合物であってもよい。また、本発明に係るデバイス形態としては、通常の液晶表示素子と同様に、２つの電極板からなるセルに挟まれた構造が好ましい。電極板としては、例えば、表面にＩＴＯを施したガラス基板やプラスチックフィルム、ＮＥＳＡガラス基板等の透明電極付基板が好ましく使用される。

【００２４】

【実施例】実施例

２量化性構造を有する重合性化合物として、図６に示すようなｐ－フェニルシンナモイロキシエチルジアクリレートを合成した。この化合物は重合性基を２個有しており、更に光２量化性構造を２個有している。また、光２量化性構造中にはフェニル基が２個存在し、低分子液晶の配向性が更に良好となるように配慮されている。ｐ－フェニルシンナモイロキシエチルジアクリレート０．２２ｇ、重合性化合物としてジペンタエリスルトールヘキサアクリレート（日本化薬社製）０．５３ｇ、重合性化合物の重合開始剤としてローズベンガル（日本化薬社製）３．５ｍｇとＮ－フェニルグリシン（和光純薬社製）０．０１ｇ、低分子液晶Ｅ７（メルク社製）０．２５ｇとを混合し、重合性組成物を調液し、透明電極（ＩＴＯ）付き石英基板を対向して張り合わせたセル（１０ミクロン）に重合性組成物を注入した。そして、４８８ｎｍのＡｒイオン・レーザー光を２光束に分け、セルの裏表からセル表面にレーザー光をそれぞれ照射した。これら２光束はセル内で干渉光を形成した。このレーザー光を１０分間照射したのち、高圧水銀灯を光源とした偏向紫外線（偏向光）を３０ｍＪ／ｃｍ^{2}の照射強度で５分間照射して、内部で屈折率が周期的に変化する層構造を有する高分子分散液晶素子を作製した。

【００２５】比較例１

重合性基の数が単数の場合の比較例として、ｐ－フェニ

ルシンナモイロキシエチルジアクリレートの代わりに、重合性基が単数であるｐ－フェニルシンナモイロキシエチルメタクリレートを用い、シンナモイロキシエチルメタクリレート、ジペンタエリスルトールヘキサアクリレートの混合量をそれぞれ０．０８ｇ、０．６７ｇとしたこと以外は上記実施例と同一の条件で、内部で屈折率が周期的に変化する層構造を有する高分子分散液晶素子を作製した。

【００２６】比較例２
光２量化性構造を有する重合性化合物を含まない比較例として、ｐ－フェニルシンナモイロキシエチルジアクリレートを用いず、ジペンタエリスルトールヘキサアクリレートの混合量を０．７５ｇとしたこと以外は上記実施例と同一の条件で、内部で屈折率が周期的に変化する層構造を有する高分子分散液晶素子を作製した。　＊

＊【００２７】＜評価試料の評価＞実施例と比較例１及び２で作製した試料の反射率と、配向特性をそれぞれ以下のようにして評価した。
＜試料の配向特性評価実験＞セナルモン補償光学系を用いてセルの異方性を測定した。セルギャップは１０μｍのものを用いた。
＜試料の反射特性評価実験＞評価試料１５の反射率は、図7に示すゴニオメーターヘッドを用いたΘ－２Θ光学系と、白色光光源１４とスペクトロメーター１３を組み合せた評価装置で評価した。
＜配向特性の評価結果＞実施例と比較例１及び２の液晶分子配向特性の評価結果を表１に示す。

【００２８】
【表１】

表１　液晶分子配向性評価結果

	実施例	比較例１	比較例２
面内異方性（ｎｍ）	８３	２０	７

【００２９】表１において、実施例と比較例１では液晶が配向して高分子分散型液晶が光学的異方性を相当有しているのに対して、比較例２では光学的異方性が小さいことがわかる。また、実施例の異方性は比較例１と比較して高くなっていることがわかる。この結果から本発明の高分子分散液晶素子は、素子中の低分子液晶の配向性が良く、素子として光学的に高い異方性を有することが※

※明らかとなった。
＜反射光強度の評価結果＞反射光強度の評価結果を表２に示す。ここでは、体積ホログラム素子の反射率特性評価の目安として、反射率３０％以下を×、３０％～５０％を△、５０％～７０％を○、７０％以上を◎とした。

【００３０】
【表２】

表２　反射特性の評価結果

	実施例	比較例１	比較例２
反射率（％）	８８	６５	４８
評　価	◎	○	△

【００３１】表２に示すように、実施例は、比較例１及び２より反射率が大幅に向上していることがわかる。本実施例では二つの光２量化性構造を有し、且つ光２量化性構造中に二つのフェニル基を有するｐ－フェニルシンナモイロキシエチルジアクリレートを用いたが、本化合物は光２量化性構造が単数の場合、更にフェニル基が単数の場合と比較して良好な配向性が得られる。また、光２量化性構造にシアノ基が付加したものを用いると更に液晶分子との相互作用が高くなり、配向性が向上する。このように本発明では、内部で屈折率が周期的に変化する層構造を有する高分子分散液晶素子中の低分子液晶の配向性が良好となり、従来よりも反射率の高い、内部で屈折率が周期的に変化する層構造を有する高分子分散液晶素子の作製が可能となる。　★

★【００３２】
【発明の効果】本発明によれば、高い反射率を有する高分子分散型液晶素子及びその製造方法を得ることができる。
【図面の簡単な説明】
【図１】従来の高分子分散型液晶の模式図であり、（ａ）は電圧非印加の状態を示し、（ｂ）は電圧印加の状態を示す。
【図２】従来の、内部で屈折率が周期的に変化する層構造を有する高分子分散液晶素子の模式図であり、（ａ）は電圧非印加の状態を示し、（ｂ）は電圧印加の状態を示す。
【図３】本発明の、内部で屈折率が周期的に変化する層構造を有する高分子分散液晶素子の製造方法の一例を示

す図であり、（ａ）はレーザー干渉光照射工程を示し、（ｂ）は偏向光照射工程を示す。

【図４】本発明の、内部で屈折率が周期的に変化する層構造を有する高分子分散液晶素子の模式図であり、（ａ）は電圧非印加の状態を示し、（ｂ）は電圧印加の状態を示す。

【図５】（ａ）～（ｄ）はそれぞれ本発明に係る光２量化構造の例を示す図である。

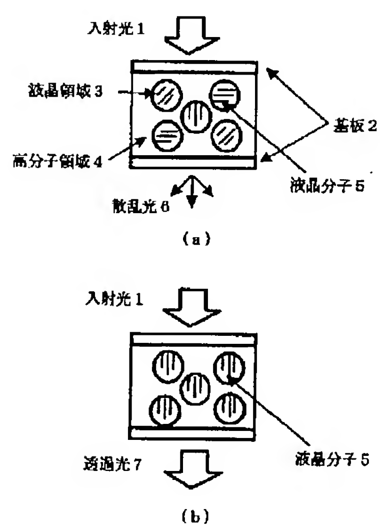
【図６】本発明の実施例に用いた化合物の構造を示す図である。

【図７】反射率評価の光学系の配置を示す図である。

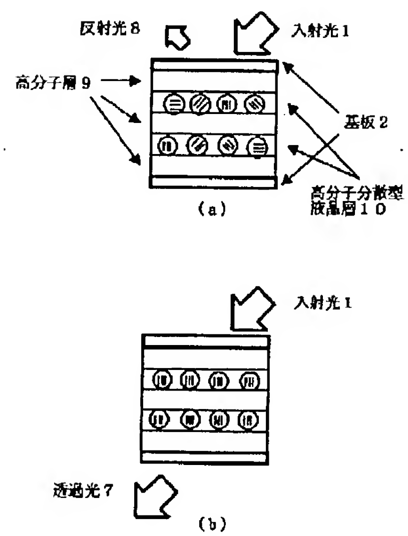
【符号の説明】

1　入射光
2　基板
3　液晶領域
4　高分子領域
5　液晶分子
6　散乱光
7　透過光
8　反射光
9　高分子層
1０　高分子分散型液晶層
1１　レーザー干渉光
1２　偏向光
1３　スペクトロメーター
1４　白色光光源
1５　評価試料

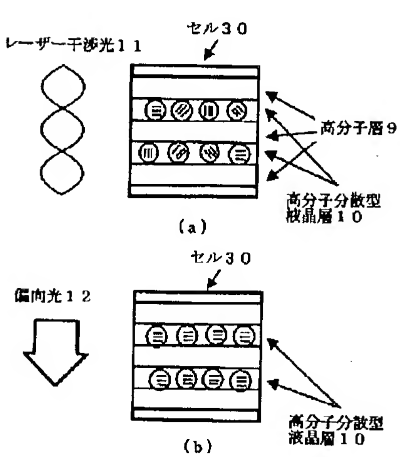
【図１】



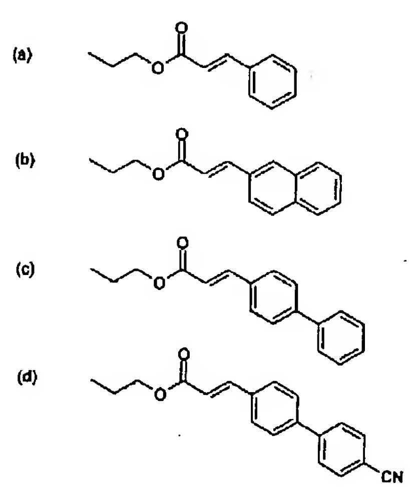
【図２】



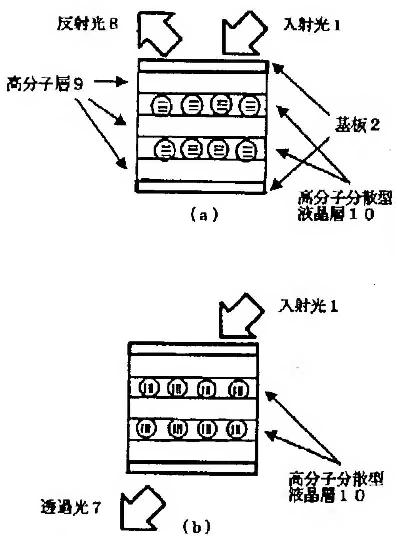
【図３】



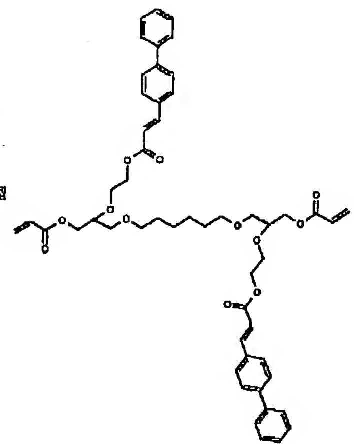
【図５】



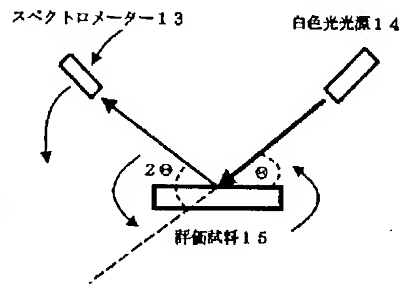
【図4】



【図6】



【図7】



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(72)発明者 氷治 直樹
神奈川県足柄上郡中井町境430 グリーンテクなかい 富士ゼロックス株式会社内

(72)発明者 鈴木 貞一
神奈川県足柄上郡中井町境430 グリーンテクなかい 富士ゼロックス株式会社内

(72)発明者 二宮 正伸
神奈川県南足柄市竹松1600番地 富士ゼロックス株式会社内

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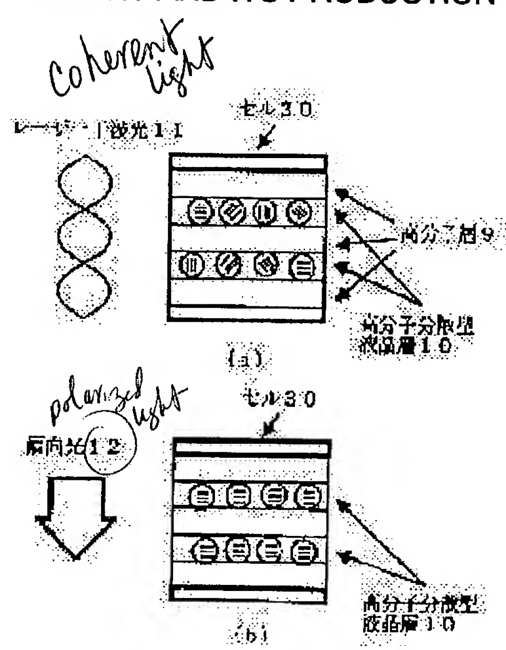
(71)Applicant : FUJI XEROX CO LTD
(72)Inventor : HIKIJI TAKETO
YAMAMOTO SHIGERU
HIJI NAOKI
SUZUKI SADAICHI
NINOMIYA MASANOBU

(54) POLYMER DISPERSION TYPE LIQUID CRYSTAL ELEMENT AND ITS PRODUCTION

(57)Abstract:



PROBLEM TO BE SOLVED: To produce a polymer dispersion type liquid crystal element having high reflectance.

SOLUTION: A polymerizable compound containing a compound having a photodimerizable structure and plural polymerizable groups, a low molecular weight liquid crystal and a polymerization initiator for the polymerizable groups are mixed to prepare a polymerizable composition, and this composition is injected into a cell 30. When the resultant cell 30 is irradiated with coherent laser light 11 in regions in which the amplitude of the light 11 is large, the polymerizable compound is cured to form polymer layers 9 having a low refractive index. In regions in which the amplitude of the light 11 is small, polymerization and phase separation are caused to form polymer dispersion type liquid crystal layers 10 having a high refractive index. When the resultant cell 30 is irradiated with polarized light 12, the low molecular weight liquid crystal in the cell 30 is aligned in a specified direction. The periodic variation of the refractive index of the layers 10 increases and the objective polymer dispersion type liquid crystal element having high

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reflectance is obtained.

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3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The polymer dispersed liquid crystal component characterized by being manufactured by carrying out polymerization phase separation of the polymerization nature compound which has optical dimerization nature structure at least, and has two or more polymerization nature machines, and the polymerization nature constituent containing low-molecular liquid crystal.
[Claim 2] The polymer dispersed liquid crystal component according to claim 1 to which a refractive index is characterized by having the layer system which changes periodically inside.
[Claim 3] The polymer dispersed liquid crystal component according to claim 1 or 2 characterized by said polymerization nature compound having two or more optical dimerization nature structures.
[Claim 4] The polymer dispersed liquid crystal component according to claim 1 to 3 to which said optical dimerization nature structure is characterized by having two or more benzene rings.
[Claim 5] The polymer dispersed liquid crystal component according to claim 1 to 3 characterized by said optical dimerization nature structure having a cyano group.
[Claim 6] The polymer dispersed liquid crystal component characterized by having the layer system from which it consists of composite constructions of the high molecular compound which carried out optical dimerization, and low-molecular liquid crystal, and a refractive index changes periodically inside.
[Claim 7] The manufacture approach of the polymer dispersed liquid crystal component characterized by carrying out polymerization phase separation of the polymerization nature compound which has optical dimerization nature structure at least, and has two or more polymerization nature machines, and the polymerization nature constituent containing low-molecular liquid crystal, irradiating deflection light and subsequently carrying out orientation of the low-molecular liquid crystal.
[Claim 8] The manufacture approach of the polymer dispersed liquid crystal component according to claim 7 which is made to carry out polymerization phase separation to said polymerization nature constituent by irradiating a standing wave, and is characterized by forming the layer system from which a refractive index changes periodically inside.
[Claim 9] The manufacture approach of the polymer dispersed liquid crystal component according to claim 8 characterized by obtaining said standing wave according to a laser interference light.
[Claim 10] The manufacture approach of the polymer dispersed liquid crystal component characterized by carrying out orientation of the low-molecular liquid crystal at the same time it irradiates and carries out polymerization phase separation of the deflection light to the polymerization nature compound which has optical dimerization nature structure at least, and has two or more polymerization nature machines, and the polymerization nature constituent containing low-molecular liquid crystal.
[Claim 11] The orientation approach of the low-molecular liquid crystal in the polymer dispersed liquid crystal component characterized by carrying out orientation of the low-molecular liquid crystal to the polymer dispersed liquid crystal component which was made to carry out polymerization phase separation of the polymerization nature compound which has optical dimerization nature structure at least, and has two or more polymerization nature machines, and the polymerization nature constituent

containing low-molecular liquid crystal, and produced them by irradiating deflection light.
[Claim 12] The orientation approach of the low-molecular liquid crystal in the polymer dispersed liquid crystal component according to claim 11 characterized by said deflection light being deflection ultraviolet rays.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the polymer dispersed liquid crystal component which can control a reflection factor and permeability by impression of electric field, a magnetic field, etc., and its manufacture approach. The polymer dispersed liquid crystal component manufactured by this invention is applicable as optical elements, such as a display, a modulated light component, and a light modulation element.
[0002]
[Description of the Prior Art] The polymer dispersed liquid crystal (PDLC) which distributed liquid crystal as the component for a display and a modulated light component all over the opening of the polymer of the three-dimensional structure as shown in drawing 1 is studied. PDLC is equipped with the liquid crystal field 3 and the macromolecule field 4 between two substrates 2, as shown in drawing. In the condition that an electrical potential difference is not impressed, as shown in drawing 1 (a), incident light 1 turns into the scattered light 6 by refracting incident light 1 by the interface according to the difference of the refractive index of the liquid crystal in an opening, and the refractive index of a polymer, and passing much DOROPU let by the whole film. If an electrical potential difference is impressed to this, as shown in drawing 1 (b), orientation of the liquid crystal molecule 5 is carried out at right angles to a substrate 2, the refractive index of the direction of a major axis of liquid crystal and its refractive index of a polymer will correspond, it will become transparent [the PDLC film], and incident light 1 will be obtained as the transmitted light 7. With the technique of this PDLC, a polarizing plate is unnecessary, the application to a projector light valve is considered, and the bright display is expected.
[0003] The structure of these three-dimension polymers has that in which the opening over which liquid crystal is distributed exists mutually-independent, and the thing distributed continuously. As the manufacture approach of such liquid crystal macromolecule bipolar membrane, it roughly divides and three approaches are proposed. The 1st is the approach of carrying out impregnation of the liquid crystal to a porosity polymer. The 2nd After making a polymer and liquid crystal mix and emulsify in a solvent, it is the approach of stiffening a polymer by evaporating a solvent. The 3rd It lets the process to which the polymerization of the polymerization nature constituent which mixed a monomer, oligomer, or those mixture and liquid crystal is carried out using means, such as an exposure of heat or ultraviolet rays, pass, and is the approach of carrying out phase separation of the liquid crystal to the polymer which carried out the polymerization.
[0004] moreover -- as application of this polymer dispersed liquid crystal -- SPIE. -- the polymer dispersed liquid crystal component from which a refractive index changes to 1080, 83, and (1989) periodically inside is indicated. Specifically, a refractive index realizes the layer system which changes periodically like drawing 2 by producing the structure which carried out the laminating of the macromolecule layer 9 and the polymer dispersed liquid crystal layer 10 by turns. In this case, in the condition that an electrical potential difference is not impressed, as shown in drawing 2 (a), incident light 1 is reflected by the principle of the interference filter resulting from the periodic refractive-index

difference of the polymer dispersed liquid crystal layer 10 and the macromolecule layer 9, and the reflected light 8 is produced. If an electrical potential difference is impressed to this, as shown in drawing 2 (b), the refractive index of the polymer dispersed liquid crystal layer 10 and the macromolecule layer 9 is in agreement, the film becomes transparent, and incident light 1 will pass the film and will turn into the transmitted light 7.

[0005]

[Problem(s) to be Solved by the Invention] There is a problem that dispersion nature is low, in the conventional PDLC as shown in drawing 1 . The refractive-index difference of a macromolecule field and a liquid crystal field depends the cause on a small thing. For this reason, the conventional PDLC is difficult to apply to the display of a direct viewing type, and that application was limited to the shutter of a projection mold. Moreover, as shown in drawing 2 , with the polymer dispersed liquid crystal component from which a refractive index changes periodically in the conventional interior, the orientation of the low-molecular liquid crystal in the DOROPU let in a polymer dispersed liquid crystal layer becomes random in the whole polymer dispersed liquid crystal layer. Therefore, the refractive index of a polymer dispersed liquid crystal layer falls to the value of {no(3-v)+ne} / 3 from the value (v) of the volume fraction to the macromolecule of the value (np is Abbreviation no) of the refractive index of the macromolecule in the refractive index (ne+2no) to which DOROPU let was approximated primarily / 3, and a polymer dispersed liquid crystal layer, and the low-molecular liquid crystal in a polymer dispersed liquid crystal layer. Here, a refractive index in case, as for np, the refractive index of a polymer and the oscillating direction of the electric field of light cross at right angles and the major axis of a liquid crystal molecule and no cross at right angles, and ne show a refractive index when the oscillating direction of the electric field of light is parallel to the major axis of a liquid crystal molecule. For this reason, the refractive-index difference of a polymer dispersed liquid crystal layer and a macromolecule layer became small, and there was a problem that a high reflection factor was not obtained. Therefore, such a technique is not known, although the technique of arranging the orientation of the low-molecular liquid crystal in a component is searched for in order to raise the reflection factor of the polymer dispersed liquid crystal component from which a refractive index changes periodically inside.

[0006] Some techniques which control the direction of orientation of the low-molecular liquid crystal in the DOROPU let in the initial state in PDLC as a similar technique are proposed. For example, the orientation control technique by the combination of PDLC which used the liquid crystallinity macromolecule for ** U.S. Pat. No. 5188760 description, and the orientation film is indicated. This technique uses a liquid crystallinity monomer for the polymerization nature constituent which is the precursor of PDLC, and injects it into a cel with the orientation film. By applying UV and heat in this condition, after the liquid crystallinity macromolecule and low-molecular liquid crystal which are the polymer of a liquid crystallinity monomer have carried out orientation in the direction of the orientation film, polymerization phase separation is performed, and the orientation of low-molecular liquid crystal is fixed after liquid crystallinity monomer hardening.

[0007] Moreover, the orientation control technique by the combination of PDLC, and a horizontal external magnetic field and electric field is indicated by ** JP,5-281527,A. With this technique, a polymerization nature constituent is poured into the interior of a cel without the orientation film, where an external magnetic field and electric field are horizontally impressed to this cel, by applying UV and heat, after low-molecular liquid crystal has carried out orientation in the direction of an external magnetic field or electric field, polymerization phase separation is performed, and the orientation of low-molecular liquid crystal is fixed after polymerization nature constituent hardening.

[0008] Moreover, **Japan The orientation control technique by the combination of PDLC and the orientation film is indicated by Display'92,699. With this technique, the polymerization nature constituent which is the precursor of PDLC is prepared so that liquid crystal concentration may serve as a very high liquid crystal phase, and it is injected into a cel with the orientation film. In this condition, although orientation of the polymerization nature constituent of a liquid crystal phase condition is carried out in the direction of the orientation film, the orientation of low-molecular liquid crystal is fixed

by applying UV and heat to this condition and carrying out polymerization phase separation inside a cel with the orientation film, with the condition of initial orientation maintained.
[0009] Furthermore, the orientation control technique using the high molecular compound which has optical dimerization nature structure is indicated by **Mol.Mat. and 2,295 (1993). This technique is produced by the impregnation method using the high molecular compound which has optical dimerization nature structure as an ingredient. First, the bipolar membrane which consists of a poor solvent of the high molecular compound which has optical dimerization nature structure by the emulsifying method, and this high molecular compound is produced, a poor solvent is extracted and dried from this bipolar membrane, and the porosity polymer which consists of a high molecular compound which has optical dimerization nature structure is produced. Furthermore, deflection light is irradiated at this porosity polymer, and an optical dimerization reaction is made to cause. The orientation restraining force over low-molecular liquid crystal is made to discover with a structural change of the high molecular compound by this optical dimerization reaction. Then, the low-molecular liquid crystal in a liquid crystal grain produces PDLC in the condition of having carried out orientation, by carrying out impregnation of the low-molecular liquid crystal to a porosity polymer.
[0010] However, by the orientation fixed approach of ** and **, in order to have to use the orientation film, a composite construction like drawing 2 was [among these] unproducible. Moreover, although an external magnetic field and electric field needed to be impressed to a cel and parallel by the orientation fixed approach of **, when cell size was large, it was dramatically difficult [it] to impress an effective external magnetic field and electric field covering the whole surface within a field of a cel. For example, when impressing external electric field, it is indicated by JP,5-281527,A that it is required for the magnitude of external electric field to be 1 or more kV/cm. Here, although applied voltage will become the count which is needed about 350kV or more if it assumes that cell size is 12 inches of vertical angles, big applied voltage in this way is easily unrealizable. Furthermore, since the high molecular compound which has optical dimerization nature structure as an ingredient is used for **, it is producible only by the impregnation method. Moreover, by the impregnation method, a composite construction like drawing 2 is unproducible. Thus, each conventional liquid crystal orientation approach has the trouble, and the polymer dispersed liquid crystal component which has sufficient reflection factor is not obtained.
[0011] Therefore, the object of this invention is to offer the polymer dispersed liquid crystal component which has a high reflection factor, and its manufacture approach.
[0012]
[Means for Solving the Problem] As a result of this invention person's etc. repeating research wholeheartedly, what has optical dimerization nature structure as a polymerization nature compound was mixed, and it found out that a liquid crystal molecule carried out orientation by irradiating deflection light after formation of a polymer dispersed liquid crystal component. Consequently, the reflection factor of HPDLC has improved. And as a result of stepping up efforts further for the improvement in image quality, when the thing containing the compound which has two or more polymerization nature machines was used as a polymerization nature compound which has optical dimerization nature structure, compared with the singular thing, the stacking tendency became [the polymerization nature machine] good, and it resulted that a reflection factor was improved further in header this invention. When a polymerization nature machine applies the monofunctional polymerization nature compound which is an unit, since it has the work which checks formation of the detailed periodic structure of HPDLC, the addition is restricted to a minute amount, therefore according to an addition not being enough, the stacking tendency of the liquid crystal by optical dimerization becomes inadequate, and only slight improvement in a property can be realized.
[0013] The polymer dispersed liquid crystal component concerning this invention has the layer system from which it is manufactured by carrying out polymerization phase separation of the polymerization nature compound which has optical dimerization nature structure at least, and has two or more polymerization nature machines, and the polymerization nature constituent containing low-molecular liquid crystal, and consists of composite constructions of the high molecular compound which carried

out optical dimerization, and low-molecular liquid crystal, and a refractive index changes periodically inside. Here, as a polymerization nature compound, what has two or more optical dimerization nature structures can be used. Moreover, as optical dimerization nature structure, the thing which has two or more benzene rings, or the thing which has a cyano group can be used.

[0014] The manufacture approach of the polymer dispersed liquid crystal component concerning this invention carries out polymerization phase separation of the polymerization nature compound which has optical dimerization nature structure at least, and has two or more polymerization nature machines, and the polymerization nature constituent containing low-molecular liquid crystal, subsequently, irradiates deflection light, carries out orientation of the low-molecular liquid crystal, and manufactures a component. Here, polymerization phase separation can be carried out to a polymerization nature constituent by irradiating a standing wave, and the layer system from which a refractive index changes periodically inside can be formed. This standing wave is obtained for example, according to a laser interference light. Moreover, by irradiating the deflection light of the wavelength in which the polymerization initiator of the high molecular compound which has optical dimerization nature structure, and a polymerization nature compound has sensibility simultaneously, while carrying out polymerization phase separation, orientation of the low-molecular liquid crystal can be carried out. As a deflection light, deflection ultraviolet rays are used, for example. Thus, by constituting, the polymer dispersed liquid crystal component which has a high reflection factor, and its manufacture approach can be acquired.

[0015]

[Embodiment of the Invention] First, an example of the manufacture approach of the polymer dispersed liquid crystal component concerning this invention is explained using drawing 3 . In this example, a polymer dispersed liquid crystal component is produced using a laser interference light. First, as shown in drawing 3 (a), the polymerization nature compound containing the compound which has optical dimerization nature structure at least, and has two or more polymerization nature machines, low-molecular liquid crystal, and the polymerization initiator of a polymerization nature machine are mixed, a polymerization nature constituent is prepared, and it pours into a cel 30. If the laser interference light 11 is irradiated, in the field where the amplitude of the laser interference light 11 is big, hardening of a polymerization nature compound will take place to this cel 30, and the macromolecule layer 9 with a low refractive index will be formed in it. Moreover, in the field where the amplitude of the laser interference light 11 is small, polymerization phase separation happens and the polymer dispersed liquid crystal layer 10 with a high refractive index is formed. Thus, since the field where the amplitude of a laser interference light is big, and a small field repeat by turns spatially, the polymer dispersed liquid crystal component from which a refractive index changes periodically is producible.

[0016] Next, the orientation approach of the low-molecular liquid crystal in a polymer dispersed liquid crystal component is described. Orientation of low-molecular liquid crystal is performed by irradiating the light (deflection light) 12 uniformly deflected for the polymer dispersed liquid crystal component produced as mentioned above, as shown in drawing 3 (b). Although the wavelength of the deflection light 12 changes with classes of high molecular compound which has optical dimerization nature structure, in the case of a cinnamate system compound, 250nm - 350nm light can be used, for example. Although the irradiation time of the deflection light 12 changes also with luminous intensity, the sensibility of optical dimerization nature structure, and exposure ambient atmospheres, in number mJ/cm2 - dozens mJ/cm2, the exposure for 1 minute - about 120 minutes has desirable luminous intensity. Moreover, when using the deflection light of the wavelength in which the polymerization initiator of the high molecular compound which has optical dimerization nature structure, and a polymerization nature compound has sensibility simultaneously, orientation control of polymerization phase separation and low-molecular liquid crystal can be performed simultaneously.

[0017] If the deflection light 12 is irradiated by the polymer dispersed liquid crystal component as mentioned above, from the anisotropy of the high-molecular-compound optical absorption multiplier which has optical dimerization nature structure, the optical dimerization nature structure of having absorption strong against a direction parallel to the oscillating direction of the deflection light 12 will

react efficiently, and the macromolecule in a macromolecule distribution liquid crystal device will carry out optical dimerization. This optical dimerization is accompanied by structural change of a molecule. With a structural change of the molecule which turned to the specific direction, as shown in drawing 3 (b), it comes to carry out orientation of the low-molecular liquid crystal in the macromolecule distribution liquid crystal device which has the layer system from which a refractive index changes periodically inside in the specific direction. Consequently, the variation of a periodic refractive index increases and a refractive index becomes producible [the macromolecule distribution liquid crystal device which has the layer system which changes periodically] in the interior where the rate of a light reflex is higher than before.

[0018] By using the compound which has optical dimerization nature structure and has two or more polymerization nature machines like this invention, the work which checks formation of the detailed periodic structure formed at the time of polymerization phase separation is reduced substantially, and degradation of the reflection factor of HPDLC by the addition of a polymerization nature compound which has optical dimerization nature structure is controlled. Therefore, while the effectiveness of the improvement in a stacking tendency by application of optical dimerization nature structure becomes still more remarkable to the reflection factor of HPDLC, addition of a lot of optical dimerization nature structures is attained, and improvement in much more reflection factor is attained. Moreover, also in the general polymer dispersed liquid crystal component using the compound which has optical dimerization structure and has two or more polymerization nature machines, phase separation nature improves as compared with the case where the ingredient which has the conventional optical dimerization nature structure is used. Therefore, by controlling the direction of orientation of the liquid crystal molecule in a polymer dispersed liquid crystal component by the exposure of the deflection light after phase separation, practical effectiveness, such as reduction of the exposure light energy which a polymerization reaction takes, and compaction of irradiation time, is acquired at the same time high light-scattering nature is obtained. Furthermore, by considering as the structure where two or more phenyl groups exist in the optical dimerization structure where two or more optical dimerization structures exist, or the structure where the cyano group is added to optical dimerization structure, the stacking tendency of low-molecular liquid crystal improves further, and the reflection factor of HPDLC is improved further.

[0019] An example at the time of using the polymer dispersed liquid crystal component concerning this invention as a volume hologram modulated light component is shown in drawing 4 . In the condition that an electrical potential difference is not impressed to a component, as shown in drawing 4 (a), incident light 1 is reflected by the principle of the interference filter resulting from the periodic refractive-index difference of the polymer dispersed liquid crystal layer 10 and the macromolecule layer 9, and the reflected light 8 is produced. Since orientation of the low-molecular liquid crystal in a macromolecule distribution liquid crystal device is carried out in the specific direction as shown in drawing, the variation of a periodic refractive index can obtain the reflected light 8 with a reflection factor it is large and higher than before here. Where an electrical potential difference is impressed to a component, as shown in drawing 4 (b), the refractive index of the polymer dispersed liquid crystal layer 10 and the macromolecule layer 9 is in agreement, the film becomes transparent, and incident light 1 passes the film and turns into the transmitted light 7.

[0020] Next, the polymerization nature constituent used for this invention is explained. A polymerization nature constituent consists of the polymerization nature compound, the low-molecular liquid crystal, and the polymerization initiator containing the compound which has optical dimerization nature structure at least, and has two or more polymerization nature machines. The optical dimerization nature structure in this invention has pointed out structure similar to the cinnamoyl radical or it which shows drawing 5 (a), and the naphthalene structure specifically shown in drawing 5 (b), the biphenyl structure shown in drawing 5 (c), the cyano biphenyl structure shown in drawing 5 (d) are mentioned. Optical dimerization nature structure is not limited to these, and the same effectiveness will be acquired if it has structure similar to these.

[0021] Moreover, the compound which has optical dimerization nature structure and has two or more

polymerization nature machines means the compound which gave two or more acryloyl radicals which are polymerization nature machines, and METAKU roil radicals to the compound with optical dimerization nature structure, and its derivative. As a concrete polymerization nature compound, cinnamyl diacrylate, cinnamyl dimethacrylate, SHINNAMO yloxy ethyl diacrylate, SHINNAMO yloxy ethyl dimethacrylate, thinner MIRIDEN ethyl diacrylate, thinner MIRIDEN ethyl dimethacrylate, etc. are raised, for example as a compound of two organic functions. Furthermore, in order to realize this invention, there is no necessity which is two organic functions, and it should just be many organic functions. In the thing of many organic functions, two organic functions, an EQC, or the effectiveness beyond it is acquired.

[0022] Moreover, the polymerization nature constituent used for this invention can be used combining various polymerization nature compounds besides it, although the polymerization nature compound which has the aforementioned optical dimerization nature structure at least is included. For example, monofunctional [, such as acrylic-acid alkyl ester, acrylamide, acrylic-acid hydroxy ester, alkyl methacrylate ester, methacrylamide, methacrylic-acid hydroxy ester, vinyl pyrrolidone, styrene and its derivative, acrylonitrile, a vinyl chloride, a vinylidene chloride, ethylene, a butadiene an isoprene, and vinylpyridine] and polyfunctional monomer are used preferably. Moreover, a polymerization initiator is contained in the polymerization nature constituent in this invention in order to carry out the polymerization of the polymerization nature compound. A polymerization initiator is chosen from the ingredients which have sensibility in the wavelength of the standing wave used in case the polymer dispersed liquid crystal component from which a refractive index changes periodically inside is produced. Furthermore, although the compound which has optical dimerization nature structure and has two or more polymerization nature machines has photosensitivity even when it is independent, by using together with sensitizing dye, a sensitizer, etc., it can make sensitization sensibility able to increase or can also choose sensitization wavelength.

[0023] Next, the low-molecular liquid crystal used for this invention is explained. Various low-molecular-liquid-crystal ingredients of the low-molecular-liquid-crystal compound which constitutes the polymer dispersed liquid crystal of this invention currently generally used as an electric-field actuation mold display ingredient, such as a nematic liquid crystal, cholesteric liquid crystal, a smectic liquid crystal, and a ferroelectric liquid crystal, are usable. Specifically, various low-molecular-liquid-crystal compounds, such as a biphenyl system, a phenyl benzoate system, a cyclohexylbenzene system, an azoxybenzene system, an azobenzene system, a terphenyl system, a biphenyl benzoate system, a cyclohexyl biphenyl system, a phenyl pyrimidine system, and a cyclohexyl pyrimidine system, are raised. These low-molecular-liquid-crystal compounds may be compounds which do not need to be single presentations and consist of two or more components like the low-molecular-liquid-crystal ingredient currently generally used. Moreover, as a device gestalt concerning this invention, the structure inserted into the cel which consists of two electrode plates is desirable like the usual liquid crystal display component. As an electrode plate, substrates with a transparent electrode, such as a glass substrate which gave ITO, and a plastic film, a NESA glass substrate, are preferably used for a front face, for example.

[0024]

[Example] p-phenyl SHINNAMOIROKISHI ethyl diacrylate as shown in drawing 6 as a polymerization nature compound which has example dimerization nature structure was compounded. This compound has two polymerization nature machines, and has two optical dimerization nature structures further. Moreover, two phenyl groups exist in optical dimerization nature structure, and it is considered so that the stacking tendency of low-molecular liquid crystal may become still better. As p-phenyl SHINNAMOIROKISHI ethyl diacrylate 0.22g and a polymerization nature compound, JIPENTAERISURU toll hexa acrylate (Nippon Kayaku Co., Ltd. make) 0.53g, As a polymerization initiator of a polymerization nature compound, rose-bengal (Nippon Kayaku Co., Ltd. make) 3.5mg and N-phenylglycine (Wako Pure Chem make) 0.01g, Low-molecular-liquid-crystal E7 (Merck Co. make) 0.25g was mixed, the polymerization nature constituent was prepared, and the polymerization nature constituent was injected into the cel (10 microns) which it countered [cel] and made the quartz

substrate with a transparent electrode (ITO) rival. And 488nm Ar ion laser light was divided into the 2 flux of lights, and laser light was irradiated on the cel front face from the both sides of a cel, respectively. The these 2 flux of light formed the interference light within the cel. After irradiating this laser light for 10 minutes, the macromolecule distribution liquid crystal device which has the layer system from which the deflection ultraviolet rays (deflection light) which made the high-pressure mercury-vapor lamp the light source are irradiated for 5 minutes by the exposure reinforcement of 30 mJ/cm2, and a refractive index changes periodically inside was produced.

[0025] Except the polymerization nature machine having set the amount of mixing of cinnamoyloxy ethylmethacrylate and JIPENTAERISURU toll hexa acrylate to 0.08g and 0.67g instead of p-phenyl SHINNAMOIROKISHI ethyl diacrylate using p-phenyl cinnamoyloxy ethylmethacrylate which is an unit, respectively as an example of a comparison in case the number of the one-fold example affinity radicals of a comparison is an unit, it is the same conditions as the above-mentioned example, and the macromolecule distribution liquid crystal device which has the layer system from which a refractive index changes periodically inside was produced.

[0026] Not using p-phenyl SHINNAMOIROKISHI ethyl diacrylate as an example of a comparison which does not contain the polymerization nature compound which has example of comparison 2 light dimerization nature structure, except having set the amount of mixing of JIPENTAERISURU toll hexa acrylate to 0.75g, it is the same conditions as the above-mentioned example, and the macromolecule distribution liquid crystal device which has the layer system from which a refractive index changes periodically inside was produced.

[0027] The orientation property was estimated as the reflection factor of the sample produced in a <assessment of assessment sample> example, and the examples 1 and 2 of a comparison as follows, respectively.

The anisotropy of a cel was measured using <orientation characterization experiment of sample> SENARUMON compensation optical system. The cel gap used the 10-micrometer thing.

The assessment equipment which combined the white light light source 14 and a spectrometer 13 with the theta-2theta optical system using the goniometer head shown in drawing 7 estimated the reflection factor of the <reflective characterization experiment of sample> assessment sample 15.

The assessment result of the liquid crystal molecular orientation property of a <assessment result of orientation property> example and the examples 1 and 2 of a comparison is shown in a table 1.

[0028]

[A table 1]

Table 1 Liquid crystal molecular orientation nature assessment result ---------------------------- An example example 1 of a comparison the example 2 of a comparison ---------------------------- Plane anisotropy (nm) 83 20 [7 ---------------------------- 0029] In a table 1, it turns out in an example and the example 1 of a comparison that optical anisotropy is small by the example 2 of a comparison to liquid crystal carrying out orientation and the polymer dispersed liquid crystal having optical anisotropy fairly. Moreover, it turns out that the anisotropy of an example is high as compared with the example 1 of a comparison. It became clear that the macromolecule distribution liquid crystal device of this result to this invention has the good stacking tendency of the low-molecular liquid crystal in a component, and has a high anisotropy optically as a component.

The assessment result of <assessment result of reflected light reinforcement> reflected light reinforcement is shown in a table 2. here -- as a rule of thumb of the reflection factor characterization of a volume hologram component, ** and 50% - 70% were made into O, and 70% or more was made [30% or less of reflection factors] into O for x and 30% - 50%.

[0030]

[A table 2]

Table 2 Assessment result of reflection property ---------------------------- An example The example 1 of a comparison The example 2 of a comparison ---------------------------- reflection factor (%) 88 65 48 ---------------------------- Criticism ** O [O [**] ---------------------------- 0031] As shown in a table 2, it turns out that the reflection factor of an example is improving substantially from the examples 1 and 2 of

a comparison. Although p-phenyl SHINNAMOIROKISHI ethyl diacrylate which has two optical dimerization nature structures, and has two phenyl groups in optical dimerization nature structure was used in this example, when optical dimerization nature structure is an unit, as for this compound, a good stacking tendency is acquired as compared with the case where a phenyl group is an unit further. Moreover, if what the cyano group added to optical dimerization nature structure is used, an interaction with a liquid crystal molecule will become high further, and a stacking tendency will improve. Thus, in this invention, a refractive index becomes good [the stacking tendency of the low-molecular liquid crystal in the macromolecule distribution liquid crystal device which has the layer system which changes periodically] inside, and a refractive index becomes producible [the macromolecule distribution liquid crystal device which has the layer system which changes periodically] in the interior where a reflection factor is higher than before.

[0032]

[Effect of the Invention] According to this invention, the polymer dispersed liquid crystal component which has a high reflection factor, and its manufacture approach can be acquired.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the mimetic diagram of the conventional polymer dispersed liquid crystal, and (a) shows electrical-potential-difference the condition of not impressing, and (b) shows the condition of electrical-potential-difference impression.
[Drawing 2] A refractive index is the mimetic diagram of the macromolecule distribution liquid crystal device which has the layer system which changes periodically in the conventional interior, and (a) shows electrical-potential-difference the condition of not impressing, and, as for (b), shows the condition of electrical-potential-difference impression.
[Drawing 3] A refractive index is drawing showing an example of the manufacture approach of the macromolecule distribution liquid crystal device which has the layer system which changes periodically inside this invention, and (a) shows a laser interference light exposure process, and, as for (b), shows a deflection light exposure process.
[Drawing 4] A refractive index is the mimetic diagram of the macromolecule distribution liquid crystal device which has the layer system which changes periodically inside this invention, and (a) shows electrical-potential-difference the condition of not impressing, and, as for (b), shows the condition of electrical-potential-difference impression.
[Drawing 5] (a) - (d) is drawing showing the example of the optical dimerization structure which starts this invention, respectively.
[Drawing 6] It is drawing showing the structure of the compound used for the example of this invention.

[Drawing 7] It is drawing showing arrangement of the optical system of reflection factor assessment.
[Description of Notations]
1 Incident Light
2 Substrate
3 Liquid Crystal Field
4 Macromolecule Field
5 Liquid Crystal Molecule
6 Scattered Light
7 Transmitted Light
8 Reflected Light
9 Macromolecule Layer
10 Polymer Dispersed Liquid Crystal Layer
11 Laser Interference Light
12 Deflection Light
13 Spectrometer
14 White Light Light Source
15 Assessment Sample